MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2015/2016

EEL3086 – SWITCHGEAR AND PROTECTION

(LE)

2nd MARCH 2016
2:30 PM – 4:30 PM
(2 Hours)

INSTRUCTION TO STUDENT

1. This question paper consists of 5 pages including cover page with 4 questions only.

2. Answer all questions. All questions carry equal marks of 25. The distribution of the marks for each question is given.

3. Please print all your answers in the Answer Booklet provided.

Question 1

a) State the purpose of current transformer (CT), and potential transformer (PT) in the protection scheme. [6 marks]

b) The working of an overcurrent relay was monitored over a period of one year. Results have shown that the relay operated 16 times (16 trips). A number of 15 were the correct trips for these trips functions, and the relay failed to issue 5 trip decisions. Calculate dependability, security and reliability of the relay.

[9 marks]

c) A fault current of 7000 A in a power system is transferred by a class C current transformer (CT) of 600:5, with a secondary burden of 3.5 Ω, and the secondray of CT is connected to a relay which is expected to operate for 7000 A fault current. Refer to Figure Q1c;

i) Check whether the CT will be saturated at this burden
ii) Comment on the ratio error of the CT used
iii) Repalce the CT with the highest value shown in Figure Q1c, and check again the CT saturation. [10 marks]

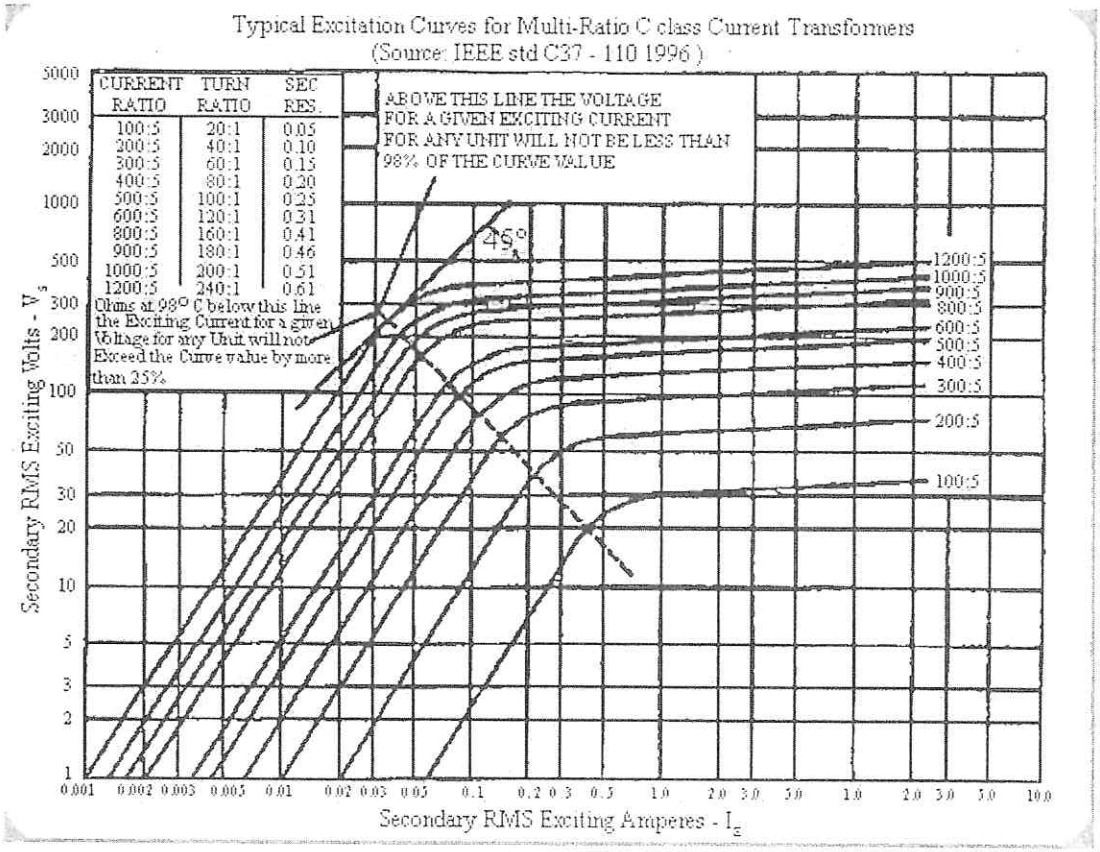
Typical Excitation Curves for Multi-Ratio C class Current Transformers
(Source: IEEE std C37 - 110 1996)
CURRENT RATIO | TURN RATIO | SEC RES.
100:5 | 20:1 | 0.05
200:5 | 40:1 | 0.10
300:5 | 60:1 | 0.15
400:5 | 80:1 | 0.20
500:5 | 100:1 | 0.25
600:5 | 120:1 | 0.31
800:5 | 160:1 | 0.41
900:5 | 180:1 | 0.46
1000:5 | 200:1 | 0.51
1200:5 | 240:1 | 0.61
Ohms at 98° C below this line the Exciting Current for a given Voltage for any Unit will not Exceed the Curve value by more than 25%
ABOVE THIS LINE THE VOLTAGE FOR A GIVEN EXCITING CURRENT FOR ANY UNIT WILL NOT BE LESS THAN 98% OF THE CURVE VALUE
45°
1200:5
1000:5
900:5
800:5
600:5
500:5
400:5
300:5
200:5
100:5
Secondary RMS Exciting Volts - V_s
Secondary RMS Exciting Amperes - I_s

Figure Q1c

Continues...

Question 2

a) A fault current of 2000 A is appeared at bus-C, refer to Figure Q2a. All of the current transformers ratios are 200:1. The relay-1 tap-setting is set on 1 A, and the relay-2 is set on 1.25 A, the time setting multiplier (TSM) for the relay-1 is set to be 2, and the time grading margin between the relays for discrimination is 0.8 sec. Both the relays have the characteristics as shown in Figure Q2a'. Calculate;

i) The time of operation of the relay-1 and relay-2 for a fault at bus C

ii) The TSM for relay-2. [10 marks]

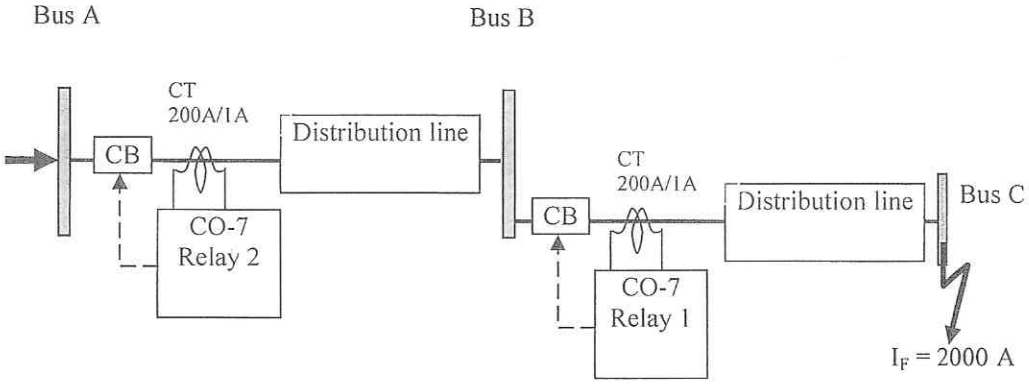

Figure Q2a

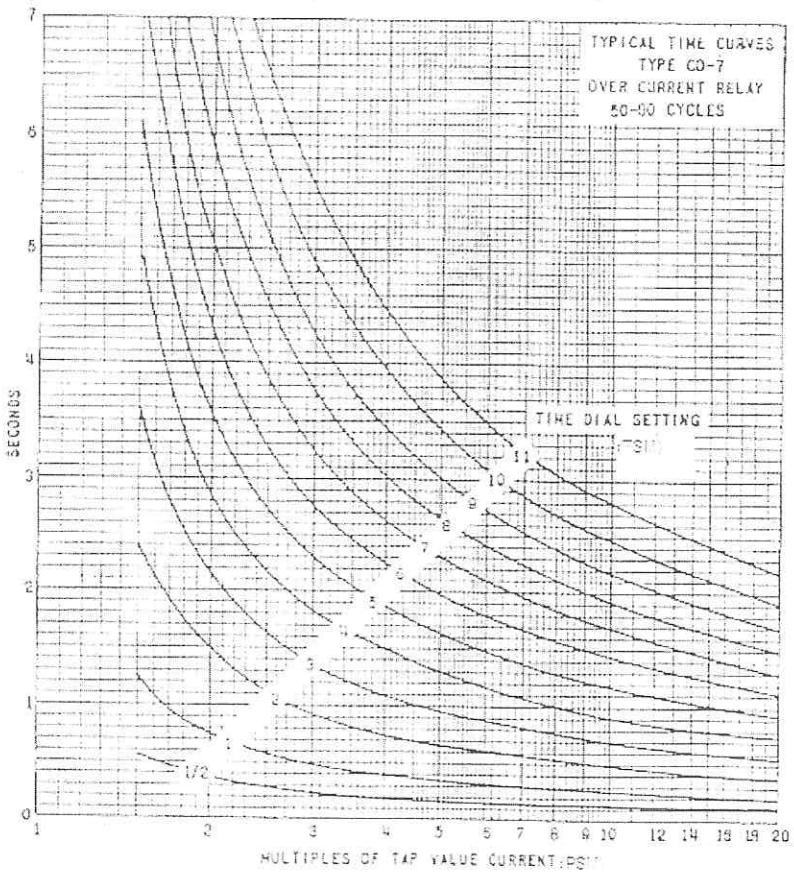

Figure Q2a'

Continues...

b) A 20 kV, 10 MVA power distribution systems with the protection scheme using inverse definite minimum time over-current relays is shown in Figure Q2b. The CT ratio of both relays is 50:1. Relay-1 starts to operate at 1 A while relay-2 starts at 1.25 A. The time grading between the relays is set at 0.8 s for discrimination. The over-current relays have the characteristics as given in Figure Q2b'.

i) Calculate the maximum allowable current in the system

ii) Identify which circuit breaker (CB) may operate first when a fault occurs at Bus C. Justify your answer

iii) Justify why relays are often discriminated by a time grading

iv) For the fault current of 500 A at bus C, determine the time setting multiplier of both relays if the operating time of relay-2 is set 1.3 sec. [15 marks]

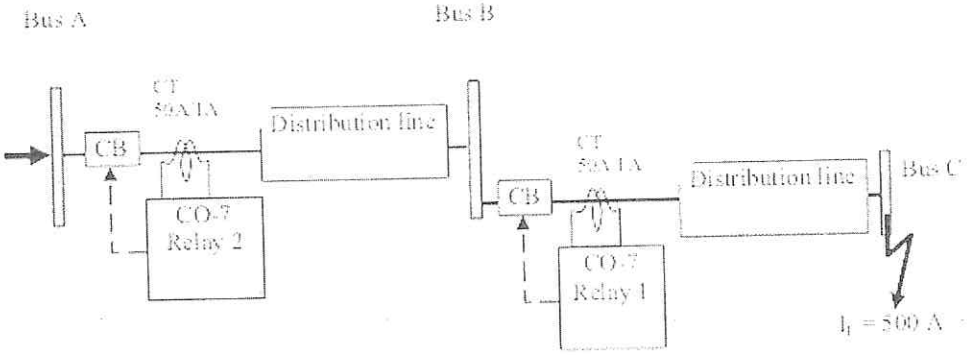

Figure Q2b

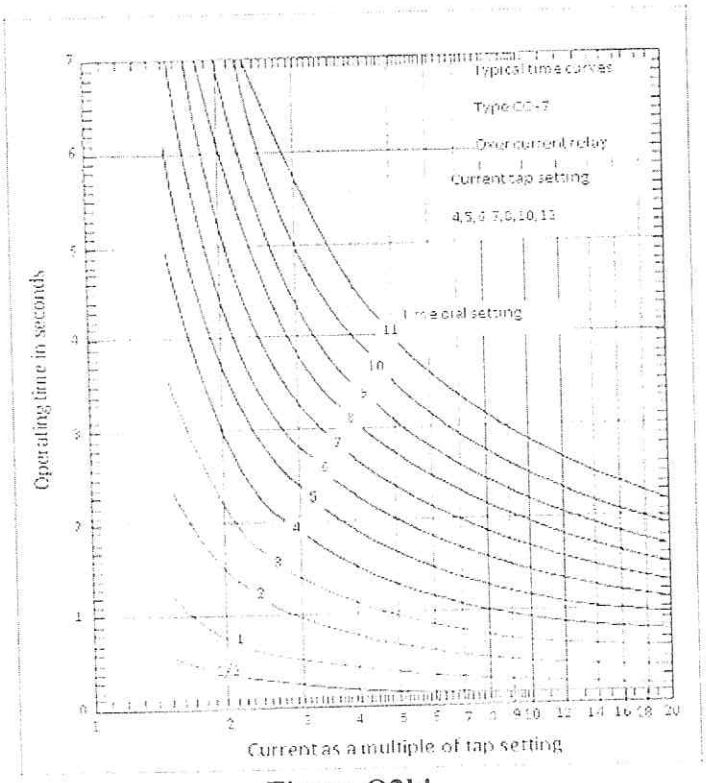

Figure Q2b'

Continues...

Question 3

a) What are the basic distance protection zones? Why different zones should be defined? [10 marks]

b) A three-stepped distance protection at station A has to be designed for the system shown in Figure Q3b. Zone 1 should protect 80% of line AB and zone 2 should cover up to 50% of the adjoining line BC. Zone 3 should be adjusted to reach up to 110% of BC. Plot the quadrilateral characteristics of the relay for all the three zones of protection assuming a maximum fault resistance of 1 ohm. [10 marks]

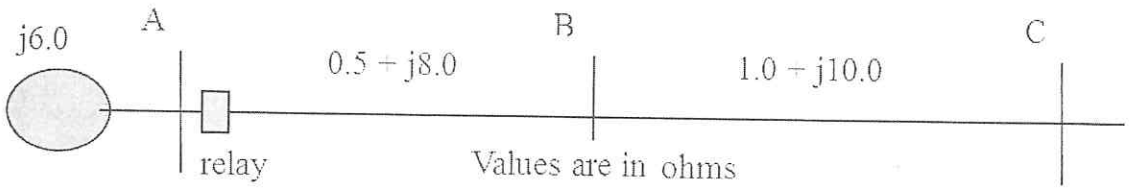

Figure Q3b

c) A 21 kV, 150 MVA alternator is provided with a differential scheme of protection. The percentage of the alternator winding to be protected against phase to ground fault is 85%. The relay is set to operate when there is 15% out of balance current. Calculate;

i) The phase voltage, and the amount of full load current

ii) The value of the resistance to be placed in the neutral to ground connection, which is required to protect 90% of the winding. [5 marks]

Question 4

a) Explain;

i) The relay time setting multiplier [4 Marks]

ii) The relay plug setting. [3 Marks]

b) Explain the function of harmonic restrained biased differential relay. [5 Marks]

c) In connection with circuit breaker arc interruption theory, with the help of diagrams and equation/s explain the following;

i) Arc voltage

ii) Voltage Race Theory

iii) Restriking voltage

iv) Rate of Rise of Restriking Voltage (RRRV). [13 marks]

...End of paper